Understanding Doppler Effect

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Course Name: Earth Systems

Core Curriculum Standard Fulfilled:

Standard I: Students will understand the scientific evidence that supports theories that explain how the universe and solar system developed.

Core Curriculum Objective Fulfilled:

Objective 1: Describe the Big Bang theory and evidence supporting it.

Intended Learning Outcomes (ILOs) Fulfilled

- 1. Use science process and thinking skills
 - 1a. Observe objects, events and patterns and record both qualitative and quantitative information.
- 6. Demonstrate understanding of the nature of science
 - 6b. Understand that science investigations use a variety of methods and do not always use the same set of procedures; understand that there is not just one "scientific method."
 - 6c. Science findings are based upon evidence.

Time Needed To Complete Inquiry: 2 class periods (1 and ½ hours)

Inquiry: What is the research question to be scientifically investigated by the students? Will you use Structured Inquiry, Guided Inquiry, or Open Inquiry as the teaching method?

- What factors affect the wavelength of a wave? (Guided inquiry)
- What is the Doppler Effect? (Structured inquiry)

Prior Knowledge Needed: What background knowledge and skills do the students need to be prepared for this inquiry? How will they obtain it?

None

Introduction: Tell how you will introduce the inquiry to your students to make it meaningful and relevant.

Start out with a class discussion of how they think the universe might have been formed—Write down their ideas. Have them list reasons why they think the universe was created this way. Discuss ways science has tried to explain the formation of the universe.

Teacher note:

• Some historical ideas are: Earth thought to be the center of the universe. The solar system is the end of the universe. The use of telescopes and the discovery of objects outside our galaxy. DO NOT DISCUSS BIG BANG THEORY AT THIS TIME

• Discuss that science uses data (evidence) to make inferences. Many past ideas of how the universe was formed do not have the evidence to support them.

Materials / Resources Needed for the Investigation:

- Slinky-1 per group
- Cafeteria trays 1 per group
- Eyedroppers 1 per group
- Clear flat-bottom dish and overhead projector

Procedures of the Investigation: Describe the actual investigation. What will the students do? If applicable, identify the independent and dependent variables, the constants, and the repeated trials.

DAY # 1: SLINKY

Teacher demonstration:

- Use a slinky and student helper to make a transverse (up-and-down) standing wave
- Draw the wave on the board and identify the following characteristics: Wave length, trough, and crest.

Activity

• Have students get into groups of 3-4. Provide students a slinky and this challenge: "In your group, make a standing wave with the slinky and then "figure out" what you can do to change the wavelength of your wave. There is more than one way to do this—find as many ways as possible. * Make sure to test only one variable at a time." (*You may need to discuss what a variable is to you class before the activity.

Data Analysis: Students should conclude:

Frequency affects wavelength:

Faster frequency → shorter wavelengths Slower frequency → longer wavelengths

Movement affects wavelength:

Moving towards = shortens wavelength Moving away = lengthen wavelength

DAY #2: WATER WAVES

- Activity:
 - o Divide class into groups of 3-4 students.
 - o Give each group 1 tray and 1 eyedropper.
 - o Have the students put about 1 cm. of water in each tray.
 - o Have students use the eye dropper to drop water in the tray at regular intervals (eye dropper to remain stationary.)

- o Have students write and draw their observations.
- o Have students move the eye dropper (source of wave making) in one direction along the tray while dropping the water.
- o Have students record and draw their observations.

• Demonstration:

- Place the flat-bottom dish on an overhead and produce waves by squeezing drops of water out of the dropper at regular intervals. (Explain that this is the frequency of the wave.)
- o This should produce waves of the same wave length.
- o Continue to make waves while moving the source toward one end of the dish.

Note: the demonstration is done to ensure that students have accurately observed the Doppler phenomenon.

• Data Analysis:

- o Notice that the distance between the waves are the same at both ends of the dish as the source of the waves stays stationary.
- o Notice that as the source moves, the waves are being produced at the same rate and travel at the same speed. Distance between the waves will be shorter in the direction of the source movement and longer on the other end of the tank.
- Summarize the observations and explain to the students that this is called the Doppler Effect.
- o Have the students think of examples of the Doppler Effect in everyday life.

Extension: To reinforce the idea of Doppler Effect a good activity to do with your class is to show them how an object producing sound coming towards you as an observer the pitch gets higher, then as it passes by the pitch gets lower.

Activity: You can have your students investigate this in several different ways.

- 1. Go to an area near the school were cars are passing by. Have your students observe what they hear. (See Student Work Sheet)
- 2. Have your students sit on the curb in the parking lot of the school. Then drive your car pass them honking the horn. Have your students observe what they hear. (See Student Work Sheet)
- 3. Or the one I do, I ride my mountain bike down the road while sounding a constants tone, with my students observing on the curb.

Note: Your students should make the observation of pitch change do to the Doppler Effect.

Shake Your Slinky! NAME		
DATE	E	
1.	Draw the wave demonstrated by the teacher and label the wavelength, crest and trough.	
2.	Precisely describe each way found to change the wavelength of a wave and the effect it had on the wavelength.	
2	Define what frequency is. How did you change the frequency of the wave?	
3.	Define what frequency is. How did you change the frequency of the wave:	

The Dropsy Family NAME		
	Draw and list 5 observations of the waves in the tank when the wave source (dropper) is stationary and has a constant frequency of drops.	
2.	Based on your slinky experience, predict what will happen to the waves when you move the dropper along the tray while keeping a constant frequency of drops.	
3.	Draw and list 5 observations of the waves in the tank when the wave source (dropper) is moving and has a constant frequency of drops.	
4.	Summarize what the Doppler Effect is.	
5. A. B.	Give three examples of the Doppler Effect in everyday life.	
С.		

Extension: Activity		
Riding	Fast: Rooommmmm	
Period:		
1.	Write down as many observations as you can about the sound comes toward you and then pass you.	
2.	Draw a picture of what you think is happening.	
3.	What is the pitch of a sound wave?	
	Describe the Doppler Effect in terms of sound. How does it compare the water drops and the slinky?	